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Project #7732

ANTI-SCALING AGENTS FOR CONCRETE

Status Report - September 1971

by
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PROJECT #7732

ANTI-SCALING AGENTS FOR CONCRETE

Abstract

The New Jersey Department of Transportation is currently engaged in a research project to evaluate anti-scaling agents for concrete surfaces. This project consists of three general phases: (I) outdoor exposure testing, (II) field testing on actual bridges, and (III) testing with a laboratory freeze-thaw chamber. This report deals primarily with Phase I and details the mixing of the concrete, the casting and curing of the test slabs, the application of anti-scaling compounds, and the outdoor exposure testing procedure. Preliminary results after one year of exposure show certain treatments to be more effective than others and confirm that adequate air entrainment is extremely important in preventing freeze-thaw deterioration.

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ANTI-SCALING AGENTS FOR CONCRETE

A study of New Jersey bridges has indicated that scaling affects approximately one-third of the concrete decks. In order to explore the possibilities for remedying this demonstrated scaling problem, a long-range research project has been undertaken.

The work of this project is being conducted in the following three phases:

Phase I

Test a relatively large number of anti-scaling agents by means of accelerated outdoor exposure tests in order to isolate a few that are promising.

Phase II

Field test on actual bridges the most promising materials found during Phase I.

Phase III

Continue testing with the aid of a laboratory freeze-thaw chamber to attempt to learn more about the actual mechanism of scaling.

Phase I was begun in the summer of 1970 with the casting of over 200 test slabs and the application of approximately 40 treatments of various types. The actual testing took place throughout the winter with water and de-icer applications timed to take advantage of the natural freeze-thaw cycles. Phase I will continue for at least one more winter, probably longer.

Phase II was begun ahead of schedule (at about the same time as Phase I) since there were a few materials thought to be beneficial based on research by others.

Phase III was initiated in late 1970 with the installation of a freeze-thaw chamber. Other associated equipment such as molds, strain frames, and a vacuum saturation tank have just been completed. Phase III testing is, therefore, just beginning and will be covered in a later report.

PHASE I

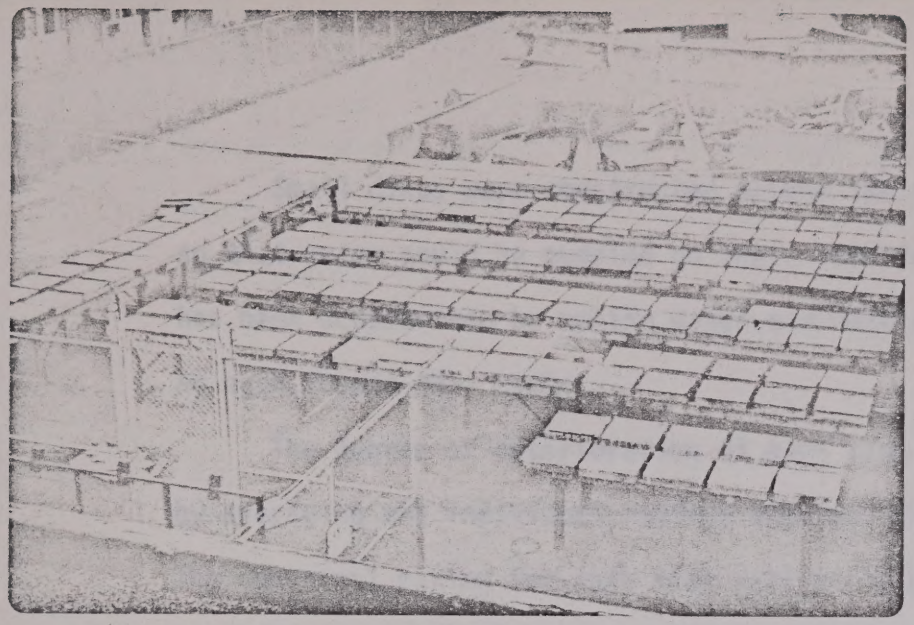
OUTDOOR EXPOSURE TESTING

Over 200 test slabs were cast using carefully controlled mixes of New Jersey Specification Class "B" concrete, approximately half with the normal amount of entrained air and half without entrained air. Because of their recognized low freeze-thaw durability, the non-air-entrained slabs were included to ensure that there would be some noticeable deterioration by the end of the first winter.

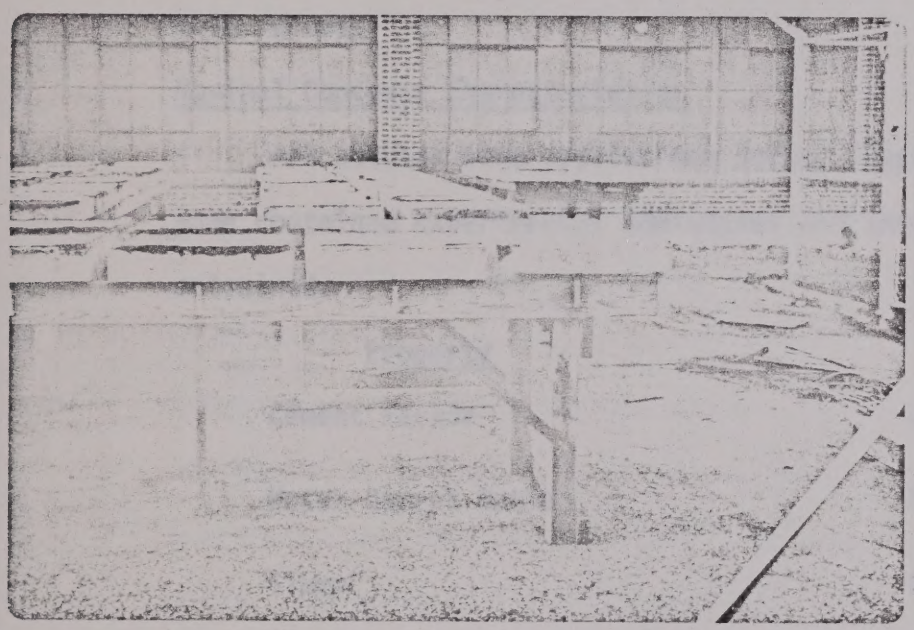
Those slabs not receiving experimental curing compounds were fog cured under controlled conditions to provide a common reference point for analysis of the results. A total of 188 of the slabs were selected for the test and were placed on elevated stands to simulate actual bridge deck temperature conditions. Figure I contains photographs taken at the test site.

Although some difficulties were experienced in applying a few of the more exotic compounds, a total of 38 anti-scaling agents were applied satisfactorily and will be evaluated in this test. Approximately two-thirds of the total number of slabs received treatments while the other one-third were left untreated as controls.

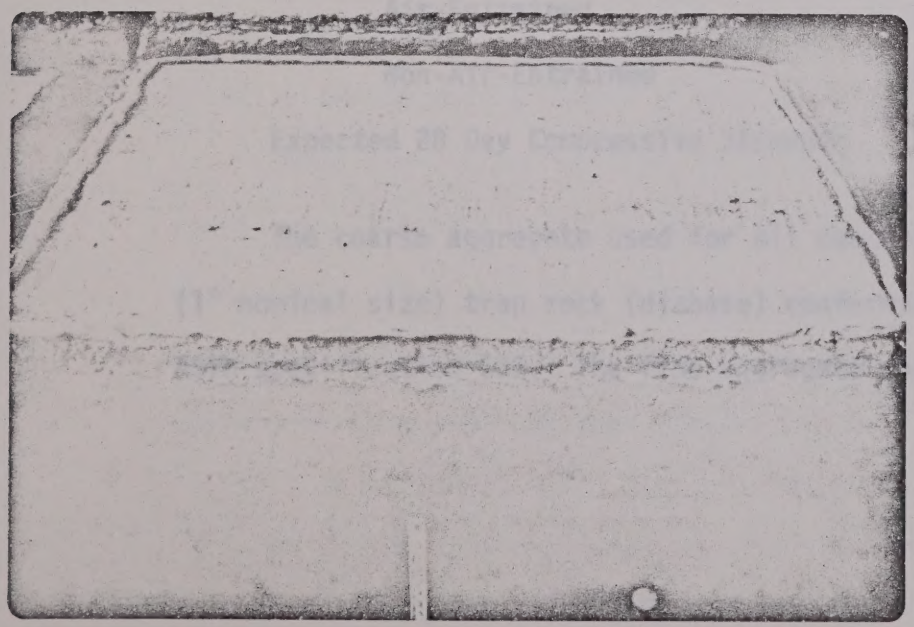
FIGURE 1



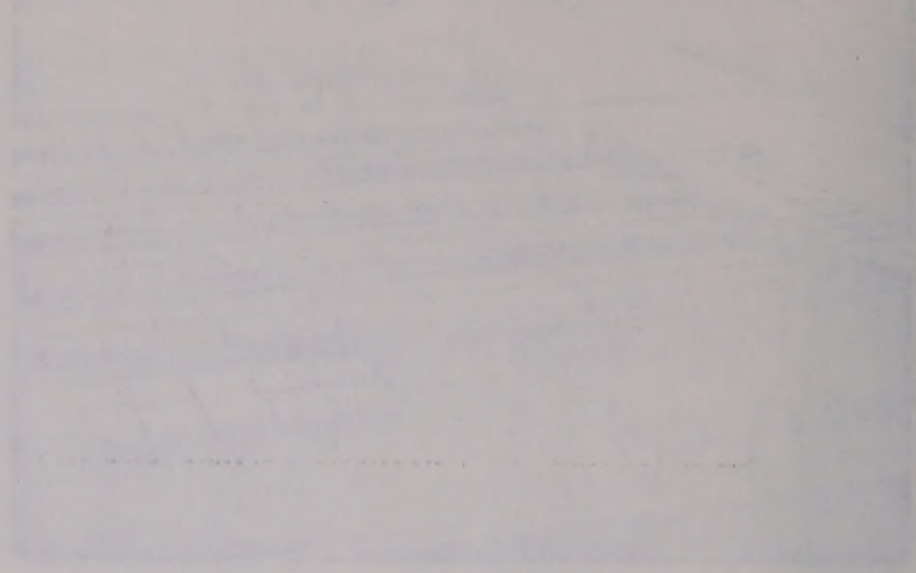
Overall view of outdoor exposure test area showing the entire group of nearly 200 test slabs.

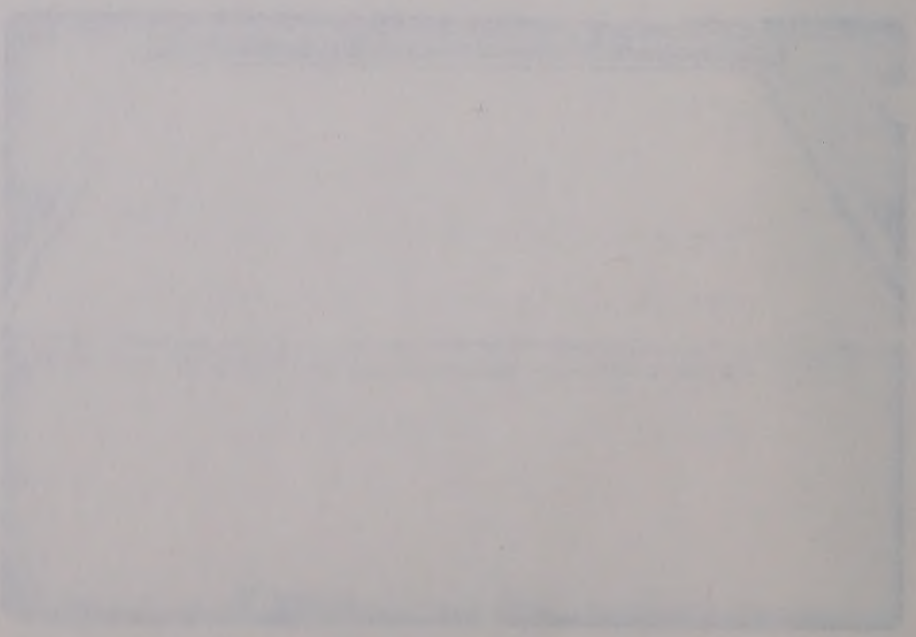


Side view showing the open wooden stands which support the test slabs at an elevation of approximately 3 ft. above the ground.



Closeup view of a test slab showing the small dikes which contain water on the surface.





Small dikes were constructed around the perimeters of all the slabs so that water could be puddled on their surfaces. The weathering process has been accelerated by making water and deicing chemicals available at each freeze-thaw cycle.

The degree of deterioration of each slab will be determined periodically by averaging the individual ratings obtained from a panel of several engineers. The numerical rating for each slab will be based on the severity and extent of scaling with the use of an appropriate rating scale described later in this report.

Nominal Concrete Characteristics

All batches were typical New Jersey Class "B" concrete except that some contained experimental admixtures and some were purposely non-air-entrained.

Property	Value
Cement Factor	$6\text{-}3/4 \pm 1/4 \frac{\text{bags}}{\text{C.Y.}}$
Water Cement Ratio	$5\text{-}1/2 \pm 1/2 \frac{\text{gals.}}{\text{bag}}$
Slump	$2\text{-}1/2 \pm 1/2$ inches
Air Content	
Air-Entrained	3 - 6%
Non-Air-Entrained	0 - 3%
Expected 28 Day Compressive Strength	4500 psi. (3-6% air)

The coarse aggregate used for all concrete batches was size 57 (1" nominal size) trap rock (diabase) conforming to the requirements of ASTM specification C33. The fine aggregate was a natural sand with a

fineness modulus of 2.7. Type II portland cement was used. The actual concrete properties for each batch are listed in Table I at the end of this report.

Casting and Curing Procedure

The material was placed in a nominal one bag mixer and dry mixed until the mixture appeared uniform. The calculated amount of water was then added followed by alternate mixing, resting, and mixing times of 3 minutes, 3 minutes, and 2 minutes respectively. A slump test was made during the 3 minute rest period and additional water was added at the start of the final mixing period, if necessary. If additional water was added, a second slump test was made before casting to check that the desired workability had been achieved.

The concrete was then placed in wooden molds measuring 2 ft. square by 4" thick and vibrated for a maximum of 30 seconds. All slabs except those receiving curing-sealing treatments have a single #3 reinforcing bar placed at mid-depth to provide a potential site for spalling. After placement, the concrete specimens were struck-off and edged and later given a burlap-drag finish after bleeding was complete.

The various anti-scaling treatments were applied at the time and in the manner specified by the manufacturers. In some cases this was prior to curing and in others it was approximately one month later.

Immediately after casting, the concrete specimens were put into a moist room (90%-100% relative humidity, 68°-74°F) where they remained for three days. They were then taken to the test site and left on the ground for approximately one week, after which time the forms were stripped and the slabs were placed on the test stands.

Treatments and Controls

The various anti-scaling materials can be divided into the following four general categories: penetrating agents, sealers, admixtures and curing-sealing compounds. Table II at the end of this report lists all the treatments tested along with brief descriptions, skid test results, and other pertinent information.

In most cases, each penetrating agent and sealer was applied to a total of four slabs, two with air entrainment and two without. The two air-entrained slabs were randomly selected, one from the group above mid-range of air content and one from the group below. Controls for the penetrating agents and sealers are slabs from the same batch which were fog cured under the conditions described previously.

For the testing of the admixtures, two slabs (instead of the usual three) were cast from each batch. Controls for these are other fog cured control slabs which have very nearly the same cement factor, water/cement ratio, air content, and slump, but without the admixture.

The curing-sealing materials were applied to both air-entrained and non-air-entrained slabs in a manner similar to the penetrating agents and sealers, with the controls being untreated slabs from the same batches. Because the fog room conditions would not only interfere with the proper application of the curing materials but would also obscure their effectiveness (or ineffectiveness) in achieving adequate curing, these slabs were stored indoors under ambient temperature and humidity conditions, for the same three day period. The controls for these slabs were stored in the same area and were cured with wet burlap. However, one control slab from one

of the batches on each day was given the usual fog cure so that it would be possible to make some comparison between the curing-sealing materials and the other three classes of treatments.

Freeze-Thaw Testing

Of the total of 188 slabs which were placed on outdoor elevated stands, all but two have watertight dikes approximately 3/8 high around their perimeters. The dikes were formed of an architectural sealing material and were later reinforced with roofing cement to guard against possible leaks.

Water was applied to these slabs to a depth of approximately 1/4" every weekday afternoon, when there was a possibility that freezing temperatures would be reached that evening. Deicing chemicals were applied in the morning to all slabs if ice was present on any of them.

The deicing compound was a 4:1 mixture of rock salt and calcium chloride, which is the mixture currently used on New Jersey highways. In order to accelerate the build-up of deicer concentrations in the concrete, the application rate was approximately three cubic inches per slab which represents approximately five times the normal amount of 500 pounds per lane mile put down on pavements.

Evaluation

The chart shown below, which has been used by several other investigators, will be used to obtain a numerical deterioration rating for each slab.

Rating Scale

Condition	Surface Appearance (Severity)
0	No scaling
1	Very slight scaling, 1/16" deep or less, virtually no coarse aggregate visible, includes laitance scaling.
2	Slight to moderate scaling, between Condition 1 and Condition 3.
3	Moderate scaling, approximately 1/8" to 1/4" deep, some coarse aggregate visible.
4	Moderate to severe scaling, between Condition 3 and Condition 5.
5	Severe scaling, approximately 1/2" or deeper. coarse aggregate completely exposed.

Sample Calculation

A slab which exhibits varying degrees of scaling, say 30% Condition 3, 20% Condition 1, and 50% with no scaling, would be rated as follows:

Extent		Severity		
.30	x	3	=	.90
.20	x	1	=	.20
.50	x	0	=	0
		Total		1.10 = Rating

Preliminary Results

Two ratings have been made, the first by six engineers in mid-February after approximately 33 freeze-thaw cycles and the second in late May by seven engineers after approximately 46 cycles. It would be premature to attempt to draw definite conclusions at this point, but some trends do seem to be indicated.

The most significant result, as expected, is the relatively better performance of the air entrained slabs compared to those without air entrainment. Several of the non-air-entrained slabs have reached ratings of nearly 5 whereas the worst of all the air-entrained slabs was 1.5 on the rating scale. The photographs in Figure II show two non-air-entrained slabs which reached total failure.

By treatment type, the admixtures appear to be performing best, the curing-sealing materials are the worst, and the penetrating agents and sealers fall somewhere in between. Within each category there is considerable variation, with some treatments being more effective and some less effective than their controls. The magnitude of the differences between general category averages is small--about a quarter of a unit on the rating scale at the most--so these conclusions should be regarded as very tentative at this stage.

PHASE II

FIELD TESTING

The field testing phase was initiated in October and November of 1970 with two curing-sealing materials and associated controls being placed in test on seven bridge spans selected from two current Interstate construction

FIGURE II

Examples of two of the non-air-entrained slabs which reached total failure after one winter of outdoor exposure (approximately 46 freeze-thaw cycles).

projects. The two products tested were a linseed oil emulsion and a chlorinated rubber epoxy, designated C-1 and C-2, respectively, in the outdoor exposure testing phase of this project and described further in Table II. North Dakota has reported favorably on this particular linseed oil formulation and both California and the Bureau of Public Roads have obtained good results with the chlorinated rubber epoxy.

Based on New Jersey tests, both materials provide adequate cure and skid resistance and thus were judged suitable to test for the additional benefit of scaling resistance.

MATERIAL	ASTM TEST C156-65 MOISTURE LOSS GMS./SQ.CM. (MUST BE .055 OR LESS)	BRITISH PORTABLE TESTER AVERAGE SKID VALUES (55 OR ABOVE IS SATISFACTORY) PRELIMINARY TESTS	ACTUAL BRIDGES
NFPA LINSEED OIL	.018	70	61
TRI-COTE 26(g)	.041	58	53*

*It is believed that the recommended application rate may have been exceeded in some areas.

Controls for the test decks are adjacent decks (or portions of the same deck) cured with either a standard white pigmented curing compound or polyethylene sheeting. As has been standard practice in the past, those decks cured by polyethylene sheeting are to be treated at a later date with a combination of linseed oil and mineral spirits.

For all of these test decks, the construction procedure from beginning to end was observed by research personnel and a bridge construction engineer. Each truckload of concrete was checked for air content (pressure method) and slump. Chace air tests were made on the finished concrete. The location and time of placement of each truckload of concrete was recorded on pour diagrams and any discrepancies or unusual occurrences were noted. This should aid in evaluating the results when the decks are periodically checked in the future.

TABLE I

CONCRETE BATCH DATA

BATCH	SLAB NUMBERS	AIR CONTENT (%)	WATER/CEMENT RATIO (GAL./SACK)	SLUMP (INCHES)	AVERAGE 28 DAY COMPRESSIVE STRENGTH (PSI)
1	28,29,30	0.6	5.4	2-1/2	6890
2	22,23,24	0.6	5.4	2-3/4	6170
3*	34,35,36	4.8	5-1/2±1/2	2-3/4	3715
4*	7,8,9	3.9	5-1/2±1/2	2-1/4	5845
5*	1,2,3,	5.4	5-1/2±1/2	2-1/2	3715
6*	67,68,69	4.9	5-1/2±1/2	2-1/2	4045
7*	13,14,15	4.8	5-1/2±1/2	3	4015
8			NOT USED		
9*	40,41,42	4.1	5-1/2±1/2	3	5080
10			NOT USED		
11	100,101,102	4.6	5.0	2-1/2	4685
12	73,74,75	4.6	5.0	3	5450
13	31,32,33	4.0	5.0	2-1/2	5840
14	61,62,63	3.8	4.8	2-1/2	5200
15	10,11,12	4.6	5.1	2-1/2	4760
16	97,98,99	5.2	5.1	1-1/2	4880
17	43,44,45	4.8	5.0	2-1/4	5590
18	37,38,39	4.8	4.9	2-1/4	5455

*The records of the fine aggregate moisture content, determined in the field at the mix site, were lost for these particular batches. Since both the slumps and the compressive strengths for these batches are normal, it is assumed that the water contents are within the desired range.

BATCH	SLAB NUMBERS	AIR CONTENT (%)	WATER/CEMENT RATIO (GAL./SACK)	SLUMP (INCHES)	AVERAGE 28 DAY COMPRESSIVE STRENGTH (PSI)
19	64,65,66	5.2	5.0	3	4680
20	70,71,72	4.8	5.0	3	4630
21	103,104,105	4.8	5.0	2-3/4	4120
22	4,5,6	4.2	5.2	2	4865
23	25,26,27	2.2	5.0	2-3/4	7360
24	19,20,21	1.3	5.0	2-1/2	6510
25*	82,83,84	1.6	$5\text{-}1/2 \pm 1/2$	1-3/4	6945
26	49,50,51	1.8	5.2	2-1/4	4795
27	16,17,18	1.3	5.1	2-1/4	6015
28	46,47,48	1.4	5.4	2	6245
29	55,56,57	1.2	5.5	2-1/4	6615
30	52,53,54	1.0	5.5	2	6000
31	109,110,111	1.1	5.8	2-1/4	7230
32	88,89,90	0.8	5.7	3	6155
33	106,107,108	1.5	5.4	2	7780
34			NOT USED		
35	58,59,60	2.3	5.5	2	6420
36	85,86,87	2.3	5.4	2-1/2	4945
37	79,80,81	1.6	5.0	2-1/2	6110
38	76,77,78	1.8	5.7	2	6205
39	112,113,114	1.5	5.4	2-1/2	6775
40			NOT USED		
41			NOT USED		
42	190	3.0	5.4	2	5175

BATCH	SLAB NUMBERS	AIR CONTENT (%)	WATER/CEMENT RATIO (GAL./SACK)	SLUMP (INCHES)	AVERAGE 28 DAY COMPRESSIVE STRENGTH (PSI)
43	95,96	4.8	5.4	2-1/2	4650
44	181,182	6.4	5.4	2-1/2	3800
45	115,116	5.0	5.4	3	4500
46		NOT USED			
47		NOT USED			
48		NOT USED			
49		NOT USED			
50	91,92	5.4	4.9	2-1/2	6880
51	119,120	5.2	5.3	2-1/2	4775
52	186,187	4.6	5.2	2	5430
53	117,118	3.0	5.4	1-3/4	5570
54	93	3.0	5.4	2	5855
55	127,128,144	1.0	6.0	3	5835
56	129,142,143	1.4	5.6	2-3/4	6185
57	125,145	0.8	5.6	3	5375
58	124,146,147	1.0	5.6	2-1/4	5975
59	133,134,135	0.7	5.7	3	5715
60	136,137,138	1.1	5.4	2	7480
61	131,132,139	1.1	5.0	2	6225
62	130,140,141	1.0	5.2	2	7075
63	123,148,149	1.0	5.0	3	5415
64	121,122,150	0.6	5.9	2-1/2	5615
65	163,164,165	4.9	5.2	2-1/4	5270

BATCH	SLAB NUMBERS	AIR CONTENT (%)	WATER/CEMENT RATIO (GAL./SACK)	SLUMP (INCHES)	AVERAGE 28 DAY COMPRESSIVE STRENGTH (PSI)
66	166,167,168	4.8	5.2	2	5175
67	152,153,154	4.8	4.9	2-1/2	4460
68	176,177,178	4.5	5.2	1-1/2	5775
69	155,156,157	5.7	5.2	3	5270
70	173,174,175	4.8	5.3	2-1/2	5065
71	158,159,160	5.4	5.8	3	4820
72	188,189	6.6	5.6	4	4220
73	161,162,169	6.0	4.9	3	4033
74	170,171,172	4.6	5.9	3	5463
75	151,179,180	3.8	6.1	3	4880
76	183,184,185	5.2	5.2	2-1/2	5170

TABLE II

ANTI-SCALING AGENTS

TEST DESIGNATION	DESCRIPTION OF MATERIAL	MANUFACTURER AND/OR TRADE NAME	APPLICATION			AVG. SKID VALUE*	SLAB IDENTIFICATION NUMBERS				MOISTURE LOSS ASTM C-156-65 GMS/CM^2 (REQ..055 OR LESS)
							AIR-ENTRAINED		NON AIR ENTRAINED		
			TIME	RATE	METHOD		TEST SLABS	CONTROL SLABS	TEST SLABS	CONTROL SLABS	
PA-1	Linseed Oil (50% Mineral Spirits)		28 days after placement	1st Coat: .025 gal/ S.Y. 2nd Coat: .015 gal/ S.Y.	Spray	68	2 4	3 6	25	27	
PA-2	Fish Oil (50% Mineral Spirits)		"	1st Coat: .025 gal/ S.Y. 2nd Coat: .015 gal/ S.Y.	Spray	67	7 10	9 12	20 24	21 23	
PA-3	Linseed and Fish Oils (50% Mineral Spirits)		"	1st Coat: .025 gal/ S.Y. 2nd Coat: .015 gal/ S.Y.	Spray	70	8 11	9 12	19 22	21 23	
PA-4	Tall Oil (50% Mineral Spirits)		"	1 Coat .045 gal/ S.Y.	Spray	74	13 44	14 45	18 47	17 48	

*These values were obtained with the British Portable Tester as described in ASTM Designation E303-66T.

SKID VALUE	INTERPRETATION
65 or above	Good
55 to 65	Generally satisfactory
45 to 55	Conditionally satisfactory (gentle curves & grades, etc.)
45 or below	Potentially slippery

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							AIR-ENTRAINED		NON AIR ENTRAINED		
			TIME	RATE	METHOD		TEST SLABS	CON-TROL SLABS	TEST SLABS	CON-TROL SLABS	
PA-5	Tung Oil (50% Mineral Spirits)		28 days after placement	1st Coat .018 gal/ S.Y. 2nd Coat .015 gal/ S.Y.	Spray	55	15 43	14 45	16 46	17 48	
PA-6	Emulsifiable Linseed Oil		"	1st Coat .025 gal/ S.Y. 2nd Coat .015 gal/ S.Y.	Spray	68	33 66	32 65	51* 58	50 60	
PA-7	Linseed Oil "Special Solvent"		"	1st Coat .025 gal/ S.Y. 2nd Coat .015 gal/ S.Y.	Spray	72	1 5	3 6	26 28	27 30	
PA-8	Polysulfide Epoxy		"	.06 gal/ S.Y.	Acid etch, then brush	67	72	70	83	82	

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							AIR-ENTRAINED		NON AIR ENTRAINED		
			TIME	RATE	METHOD		TEST SLABS	CON-TROL SLABS	TEST SLABS	CON-TROL SLABS	
PA-10	Polymerized Solution of metal organic compounds		28 days after placement	.05 gal/ S.Y.	Spray	71	34 37	36 38	53 55	54 57	
PA-12	Soybean Oil (50% Mineral Spirits		"	2 Coats .02 gal/ S.Y.each	Brush	64	99	97	110	111	
PA-12	Soybean Oil (Uncut)		"	1 Coat .02 gal/ S.Y.	Brush	59	102	101	113	112	
PA-13	Castor Oil (50% Mineral Spirits)		"	2 Coats .02 gal/ S.Y.each	Brush	71	98	97	108	107	
PA-13	Castor Oil (Uncut)		"	1 Coat .02 gal/ S.Y.	Brush	70	100	101	114	112	

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							AIR-ENTRAINED		NON AIR ENTRAINED		
			TIME	RATE	METHOD		TEST SLABS	CON-TROL SLABS	TEST SLABS	CON-TROL SLABS	
PA-14	Linseed Oil (Uncut)		28 days after placement	1 Coat .02 gal/ S.Y.	Brush	63	104	103	109	111	
PA-15	Chlorinated Rubber Epoxy		"	.035 gal/ S.Y. on AE Slabs .057 gal/ S.Y. on NAE Slabs	Spray	54	35 39	36 38	52 56	54 57	
PA-17	Chemstop Waterproofing Compound		"	.065 gal/ S.Y.	Spray	65	68 73	69 74	79 85	80 87	
PA-18	Penetrating Epoxy		"	Primer .055 gal/ S.Y. Seal Coat .14 gal/ S.Y.	Brush	74	75	74	84	82	
S-1	Tar-Based Sealer		"	.05 gal/ S.Y.	Spray at 140-180°F	78	105	103	106	107	

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							AIR-ENTRAINED		NON AIR ENTRAINED		
			TIME	RATE	METHOD		TEST SLABS	CONTROL SLABS	TEST SLABS	CONTROL SLABS	
S-2	Resin-Based Sealer		28 days after placement	Trial .05 gal/ S.Y.	Spray No heat	75	67 71	69 70	81 86	80 87	
S-3	Styrene Butadiene		"	.05 gal/ S.Y.	Brush plus sand	67	63	61	88	90	
S-4	Urethane		"	.05 gal/ S.Y.	Brush plus sand	61	62	61	89	90	
S-5	Furan Resin		"	.05 gal/ S.Y.	Acid wash then brush plus sand	58	41	42			
S-6	Epoxy Resin		"	.09 gal/ S.Y.	Acid wash then brush plus sand	66	40	42			
S-8	Butyrate Polymer		"	.03 gal/ S.Y.	Brush	33	31	32	49 59	50 60	

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							AIR-ENTRAINED		NON AIR ENTRAINED		
			TIME	RATE	METHOD		TEST SLABS	CON-TROL SLABS	TEST SLABS	CON-TROL SLABS	
A-1	Reactive Silane		Add at mixer	1.5 lbs/ C.Y.	Add at same time as mix water	84	91	119	-	-	
A-3	Polymerized solution of metal organic compounds		"	Replaces 0.5 gal/ C.Y. of water	Add after mix water	70	93	117	-	-	
A-4	Calcium chloride based waterproof-ing agent		"	Replaces 1.5 gal/ C.Y. of water	Add at same time as mix water	71	115 181 116 182	95 189 (Fog Cure) 96 189 (Dry Cure)*			
A-5	Multi-component, chloride free, water reducing admixture		"	4 oz. per 100 lbs cement	Add with mix water	81	186 187	176			

*Manufacturer claims no cure necessary.

TABLE II

ANTI-SCALING AGENTS

TEST DESIGNATION	DESCRIPTION OF MATERIAL	MANUFACTURER AND/OR TRADE NAME	APPLICATION			AVG. SKID VALUE	SLAB IDENTIFICATION NUMBERS				MOISTURE LOSS ASTM C-156-65 GMS/CM^2 (REQ..055 OR LESS)
							AIR-ENTRAINED		NON AIR ENTRAINED		
			TIME	RATE	METHOD		TEST SLABS	CONTROL SLABS	TEST SLABS	CONTROL SLABS	
C-1	Linseed Oil Emulsion(Diluted with 1/3 water)		May be placed on wet conc.	.045 gal/ S.Y.	Spray	70	154 177	152 176	135 136	134 137	.018
C-2	Chlorinated rubber epoxy		Just after surface water disappears	.045 gal/ S.Y.	Spray	58	153 178	152 176	128 129	127 142	.041
C-3	Reactive Silane		Just after finishing	.045 gal/ S.Y.	Spray	60	156 175	157 174	144 145	127 -	.013
C-4	Master Builders Curing Compound		When conc. is hard enough to prevent marring	.045 gal/ S.Y.	Brush	77	158 173	159 174	146 125	147 -	.08 (other agencies report less)

TABLE II

ANTI-SCALING AGENTS

TEST DESIGNATION	DESCRIPTION OF MATERIAL	MANUFACTURER AND/OR TRADE NAME	APPLICATION			AVG. SKID VALUE	SLAB IDENTIFICATION NUMBERS				MOISTURE LOSS ASTM C-156-65 GMS/CM^2 (REQ..055 OR LESS)
							AIR-ENTRAINED		NON AIR ENTRAINED		
			TIME	RATE	METHOD		TEST SLABS	CON-TROL SLABS	TEST SLABS	CON-TROL SLABS	
C-5	Two component Epoxy		Just after surface water disappears	.045 gal/ S.Y.	Brush	38	165 166	164 167	122 149	121 148	.100
C-6	Epoxy Modified Acrylic Polymer		"	.045 gal/ S.Y.	Spray	65	162 163	169 164	123 124	148 147	.191
C-7	Chlorinated Rubber Curing Compound(Higher Solids Content)		1 to 2 hrs after finishing	.045 gal/ S.Y.	Brush	59	160 171	159 172	140 131	130 132	.038
C-8	Chlorinated Rubber Curing Compound(Lower Solids Content)		"	.045 gal/ S.Y.	Spray	56	161 170	169 172	139 138	132 137	.193

TABLE II

ANTI-SCALING AGENTS

TEST DESIGNATION	DESCRIPTION OF MATERIAL	MANUFACTURER AND/OR TRADE NAME	APPLICATION			AVG. SKID VALUE	SLAB IDENTIFICATION NUMBERS				MOISTURE LOSS ASTM C-156-65 GMS/CM² (REQ..055 OR LESS)
			TIME	RATE	METHOD		AIR-ENTRAINED		NON AIR ENTRAINED		
							TEST SLABS	CON-TROL SLABS	TEST SLABS	CON-TROL SLABS	
C-0	N.J.Specification quality white pigmented curing compound		Membrane curing compound applied soon after finishing. Oils applied approx. 28 days later	Both curing compound and oils applied at .045 gal/sy	Spray for both curing compou and oils	74	185	183 184			Less than .055
PA-4 on C-0	Tall oil and mineral spirits on Orion Membrane curing compound					65	179	185			
PA-5 on C-0	Tung oil and mineral spirits on Orion Membrane curing compound					42	151	185			
LO-MS on C-0	Linseed oil and mineral spirits on Orion Membrane curing compound					39	180	185			

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